

Evaluation of Hybrids for Milling and Eating Quality Traits Under Varying Environments in Rice

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Abstract— The present investigation was carried out on three notified rice hybrids namely, Hybrid 6201, Hybrid 6444 and Hybrid KRH 2 and one high yielding variety IR 64 during kharif 2006 and kharif 2007 at two locations i.e. Simbhaoli (U.P.) and Hyderabad (Andhra Pradesh) to compare the physical (milling and head rice recovery) and chemical characteristics (amylose content, gelatinization temperature and aroma) of these hybrids and inbred variety IR 64. The results showed that the mean performance for milling recovery and head rice recovery were higher at Hyderabad during both the seasons. Amylose content and gelatinization temperature showed milar values at both the locations. Further, the milling and head rice recovery of V3 (Hybrid 6444) was more as compared to IR 64. Aroma of V3 (Hybrid 6444) lost after ageing of three and six months. Further, milling recovery and head rice recovery increased with increase in ageing from one month to six months. It can be recommended that if hybrids are planted at the density of 33 plants per hill with two seedlings planted per hill and the harvest is aged for six months before milling, high head rice yields can be obtained.

Keywords— Aroma, gelatinization temperature, hybrids, head rice yield, milling recovery.

I. INTRODUCTION

Rice is the second most important food crop of the world. Feeding more than one half of the world's population, over 90% of rice is produced and consumed in Asia. There is hardly any crop plant that grows under as diverse agro-climatic conditions as rice does. Nevertheless, conditions relatively optimal for high productivity and normal growth are deep non-injurious soils, enough water, high temperature and ample solar radiation throughout the growing season. Although hybrids have proved to be higher yielder than many of the inbred varieties, but it is still facing a tough challenge in terms of acceptance from the farmer owing to the perception of poor grain quality specially the head rice recovery nullifying the advantage of hybrids that have in grain yield. The yield and other grain quality characters are genetically controlled, but they are also affected by environmental and agronomic factors like time of harvest, moisture percent, ageing and milling conditions (Virmani, 1994). The different cultivation package in hybrid rice production could be a cause for the differential grain maturity and grain moisture content at harvest, leading to low head rice yield during milling. The present study has been designed to study the effect of ageing on milling and other quality characters in three hybrids and one inbred variety under two locations during two years.

II. MATERIALS AND METHOD

The material for the present study consisted of three most popular hybrids viz., KRH-2, PA 6201 and PA 6444 and one popular high yielding variety IR 64. The seeds of these three hybrids along with the check variety were sown in nursery during kharif 2006 and 2007. Twenty five days old seedlings of these entries were carefully transplanted in the main field at two locations i.e. Simbhaoli (U.P.) and Hyderabad during 2006 and 2007. These experiments were designated as follows:

- Experiment 1 - conducted at Hyderabad during 2006
- Experiment 2 - conducted at Hyderabad during 2007
- Experiment 3 - conducted at Simbhaoli during 2006
- Experiment 4 - conducted at Simbhaoli during 2007

The experiments were laid out in a split - split plot design, with number of seedlings planted per hill as main plot, plant density as sub-plot and genotypes as sub-sub plots in three replications. Standard cultural practices were adopted to raise a normal healthy crop. All the plots were separately harvested at 18-20% grain moisture and dried under shade till the moisture content reached 14%. Three samples of 1 kg each from each plot was taken and stored for ageing at room temperature. Data on milling yield, head rice recovery, amylose content, gelatinization temperature and aroma was recorded from these samples after one, three and six months. The plot means were used for the different statistical analysis as suggested by Panse and Sukhtame (1967).

III. RESULTS & DISCUSSION

The mean squares due to milling and head rice recovery, amylose content, gelatinization temperature and aroma at one, three and six months of ageing showed significant differences among treatments due to variety and its interactions in all the four experiments (data not presented in the tables) indicating that the varieties used in the present study were significantly diverse from each other. M-6 (milling recovery after six months of ageing) recorded the highest mean milling recovery followed by M-3 (milling recovery after three months of ageing) and M-1 (milling recovery after one month of ageing) in all the experiments (Table 1) indicating the positive effect of ageing on milling recovery. Sulochana and Dakshinamurthy (2002) had also reported that milling recovery after six months of storage reduced milling breakage. V₃ (Hybrid-6444) recorded the highest and V₁ (IR 64) recorded the lowest milling recovery in all the cases (Table 1). Milling recovery of V₃ (Hybrid 6444) was significantly more than milling recovery of V₁ (IR 64) and V₄ (Hybrid KRH-2) after one month of ageing suggesting that milling recovery of hybrids cultivated and stored under similar environmental and agronomic conditions can yield more than popular inbred varieties. Similar results were also reported by Hariprasanna *et al.* (2006).

TABLE -1 : MILLING RECOVERY OF HYBRIDS AS COMPARED TO IR 64.

Variety	Experiment - 1			Experiment - 2			Experiment - 3			Experiment - 4		
	M1	M3	M6	M1	M3	M6	M1	M3	M6	M1	M3	M6
V1 (IR 64)	64.41	69.61	70.69	63.75	68.89	69.77	61.37	66.49	69.61	66.09	69.47	70.58
V2 (Hybrid 6201)	67.74	69.53	70.97	66.81	68.78	69.95	64.48	66.65	69.53	69.34	69.23	70.6
V3 (Hybrid 6444)	68.88 ^{bf}	70.68	71.82	68.01 ^{bf}	70	71.03	65.5 ^{bf}	67.49	70.67	70.34 ^f	70.32	71.57
V4 (Hybrid KRH-2)	64.41	69.05	71.5	63.78	68.52	70.85	61.41	65.69	69.05	65.83	68.86	70.68
Mean	66.36	69.72	71.25	65.59	69.05	70.4	63.19	66.58	69.72	67.9	69.47	70.86
SE	1.41	1.18	1.11	1.29	1.09	1.01	1.29	1.1	1.18	1.35	1.09	1.02
LSD at 5%	3.95	3.31	3.13	3.61	3.07	2.83	3.64	3.09	3.31	3.78	3.05	2.87

a = V1 vs V2; *b* = V1 vs V3; *c* = V1 vs V4; *d* = V2 vs V3; *e* = V2 vs V4; *f* = V3 vs V4 - means differ Significantly at *P* = 0.05

TABLE - 2 : HEAD RICE RECOVERY OF HYBRIDS AS COMPARED TO IR 64.

Variety	Experiment - 1			Experiment - 2			Experiment - 3			Experiment - 4		
	H1	H3	H6	H1	H3	H6	H1	H3	H6	H1	H3	H6
V1 (IR 64)	60.58 ^c	62.34	63.52	59.7 ^c	60.72	62.67	58.22 ^c	60.05	60.28	59.29 ^c	59.91	62.12
V2 (Hybrid 6201)	57.78	59.57	61.02	58.08 ^c	58.25	60.15	55.73	57.33	57.59	56.67	57.29	59.56
V3 (Hybrid 6444)	59.82 ^f	65.01 ^{df}	66.12 ^{bdf}	59.31 ^f	63.53 ^f	65.23 ^f	57.83 ^f	63.03 ^{df}	62.42 ^{df}	58.49 ^f	62.67 ^f	64.79 ^{df}
V4 (Hybrid KRH-2)	54.62	59.29	61.74	53.86	57.81	61.02	52.91	57.23	58.47	53.2	56.98	59.76
Mean	58.2	61.55	63.1	57.74	60.06	62.27	56.17	59.4	59.69	56.92	59.21	61.56
SE	1.47	1.24	1.17	1.46	1.14	1.1	1.36	1.16	1.02	1.43	1.17	1.09
LSD at 5%	4.13	3.48	3.29	4.08	3.21	3.09	3.8	3.25	2.87	4.01	3.28	3.07

a = V1 vs V2; *b* = V1 vs V3; *c* = V1 vs V4; *d* = V2 vs V3; *e* = V2 vs V4; *f* = V3 vs V4 - means differ Significantly at *P* = 0.05

Further, experiment-1 (Hyderabad 2006) and experiment-2 (Hyderabad 2007) recorded the higher mean head rice recovery in all the ageing durations (Table 2) than at Experiment-3 (Simbhaoli 2006) and experiment-4 (Simbhaoli 2007), indicating that the less humid conditions at Hyderabad to be more conducive for reducing breakage. V₃ (Hybrid 6444) showed significantly higher head rice recovery (HRR) over V₂ (Hybrid 6201) and V₄ (Hybrid KRH-2) in most of the cases. Similar to the present results, Khush *et al.* (1979) also reported that humidity at ripening and post harvest handling operations influenced the grain breakage during milling.

The mean values of amylose content of V₃ (Hybrid 6444) and V₁ (IR 64) was significantly superior than that of V₂ (Hybrid 6201) and V₄ (Hybrid KRH-2) and also the mean values of V₃ (Hybrid 6444) were significantly higher than V₂ (Hybrid

6201) and V₄ (Hybrid KRH-2) indicating that these hybrids will cook softer and will stay softer for longer time (Table 3). Khush *et al.* (1988) had reported that higher amylose containing genotypes cook softer.

TABLE -3 : AMYLOSE CONTENT OF HYBRIDS AS COMPARED TO INBRED VARIETY IR 64

Variety	Experiment - 1			Experiment - 2			Experiment - 3			Experiment - 4		
	A1	A3	A6	A1	A3	A6	A1	A3	A6	A1	A3	A6
V1 (IR 64)	23.47 ^{ac}	23.59 ^{ac}	24.67 ^{ac}	23.20 ^{abc}	23.26 ^{abc}	23.97 ^{ac}	23.93 ^{ac}	23.73 ^{ac}	24.20 ^{ac}	23.08 ^{ac}	24.14 ^{abc}	24.05 ^{ac}
V2 (Hybrid 6201)	21.41	21.12	22.12	21.19 ^e	20.89 ^e	21.51	21.85	21.27	21.70	21.03	21.58 ^e	21.62
V3 (Hybrid 6444)	23.15 ^{df}	22.89 ^{df}	23.81 ^{df}	22.94 ^{df}	22.36 ^{df}	23.08 ^{df}	23.62 ^{df}	23.01 ^{df}	23.41 ^{df}	22.73 ^{df}	22.81 ^f	23.18 ^{df}
V4 (Hybrid KRH-2)	20.47	20.27	21.32	20.28	19.98	20.65	20.96	20.51	20.91	20.10	20.41	20.83
Mean	22.13	21.97	22.98	21.9	21.62	22.3	22.59	22.13	22.55	21.73	22.23	22.42
SE	0.35	0.35	0.4	0.32	0.31	0.35	0.32	0.31	0.35	0.34	0.34	0.36
LSD at 5%	0.97	0.99	1.13	0.89	0.88	0.98	0.9	0.88	0.98	0.96	0.95	1.01

$a = V1$ vs $V2$; $b = V1$ vs $V3$; $c = V1$ vs $V4$; $d = V2$ vs $V3$; $e = V2$ vs $V4$; $f = V3$ vs $V4$ - means differ Significantly at $P = 0.05$

Similarly, gelatinization temperature of V₃ (Hybrid 6444) and V₄ (Hybrid KRH-2) was significantly more than that of V₁ (IR 64) and V₂ (Hybrid 6201), suggesting that IR 64 and Hybrid 6201 will cook in lesser temperature than Hybrid 6444 and KRH-2 (Table 4). Juliano *et al.* (1965) had reported that rices with higher GT seems to require a longer time to cook.

TABLE -4 : GELATINIZATION TEMPERATURE OF HYBRIDS AS COMPARED TO INBRED VARIETY IR 64

Variety	Experiment - 1			Experiment - 2			Experiment - 3			Experiment - 4		
	G1	G3	G6	G1	G3	G6	G1	G3	G6	G1	G3	G6
V1 (IR 64)	4.08	4.06	4.13	4.01	3.79	3.96	4.04	4.13	4.2	3.94	3.99	4.1
V2 (Hybrid 6201)	4.61 ^a	4.58 ^a	4.64 ^a	4.52 ^a	4.28 ^a	4.46 ^a	4.54 ^a	4.66 ^a	4.7 ^a	4.45 ^a	4.5 ^a	4.61 ^a
V3 (Hybrid 6444)	5.03 ^{bd}	5.01 ^{bd}	5.09 ^{bd}	4.97 ^{bd}	4.66 ^{bd}	4.87 ^{bd}	5 ^{bd}	5.11 ^{bd}	5.16 ^{bd}	4.89 ^{bd}	4.93 ^{bd}	5.05 ^{bd}
V4 (Hybrid KRH-2)	5.13 ^{ce}	5.1 ^{bd}	5.14 ^{bd}	5.06 ^{bd}	4.77 ^{bd}	4.96 ^{bd}	5.05 ^{bd}	5.14 ^{bd}	5.16 ^{bd}	4.94 ^{bd}	5.01 ^{bd}	5.12 ^{bd}
Mean	4.72	4.69	4.75	4.64	4.37	4.56	4.66	4.76	4.8	4.55	4.61	4.72
SE	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.07	0.07	0.07
LSD at 5%	0.19	0.2	0.2	0.19	0.18	0.17	0.17	0.18	0.17	0.19	0.2	0.2

$a = V1$ vs $V2$; $b = V1$ vs $V3$; $c = V1$ vs $V4$; $d = V2$ vs $V3$; $e = V2$ vs $V4$; $f = V3$ vs $V4$ - means differ Significantly at $P = 0.05$

TABLE - 5 : AROMA OF HYBRIDS AND VARIETY IR 64

Variety	Experiment - 1			Experiment - 2			Experiment - 3			Experiment - 4		
	AR1	AR3	AR6	AR1	AR3	AR6	AR1	AR3	AR6	AR1	AR3	AR6
V1 (IR 64)	0	0	0	0	0	0	0	0	0	0	0	0
V2 (Hybrid 6201)	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*
V3 (Hybrid 6444)	1*	1*	0.74*	1*	0.7*	0.5*	1*	1*	1*	1*	1*	1*
V4 (Hybrid KRH-2)	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*	1*
Mean	0.75	0.75	0.69	0.75	0.69	0.63	0.75	0.75	0.75	0.75	0.75	0.75
SE	0	0	0.04	0.00	0.04	0.05	0	0	0	0	0	0
LSD at 5%	0	0	0.12	0	0.11	0.14	0	0	0	0	0	0

* = Significant at $P = 0.05$

V₁ (IR 64) was non-aromatic in all duration of ageing and in all the experiments (Table 5). V₂ (Hybrid 6201) and V₄ (Hybrid KRH-2) were aromatic in all durations of ageing and in all the experiments. V₃ (Hybrid 6444) was aromatic in all durations of ageing at Simbhaoli (experiment-1 and experiment-2) but at Hyderabad it lost its aroma in some cases after three and six months of ageing (Table 5), indicating that aroma could be lost under warmer temperatures prevailing during maturity and storage. Hyderabad was drier and warmer than Simbhaoli during the maturity and storage time of this experiment. Rao *et al.* (2000) and Xu *et al.* (2006) had also reported that at low day mean temperatures aroma was superior than at higher day mean temperatures.

From the above discussion it can be concluded that the mean performance for milling recovery and head rice recovery were higher at Hyderabad in both the seasons. Amylose content and gelatinization temperature showed similar values at both the locations. Further, the milling and head rice recovery of V₃ (Hybrid 6444) was more as compared to IR 64. The present study also bring into light that hybrids have physical grain quality characters equal or even higher than the popular inbred variety IR 64. Thus, it can be recommended that if hybrids are planted at the density of 33 plants per m² with two seedlings planted per hill and the harvest is aged for six months before milling, high head rice yields can be obtained.

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